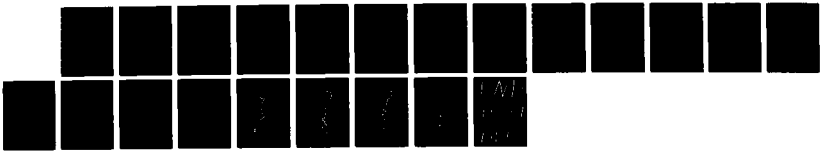
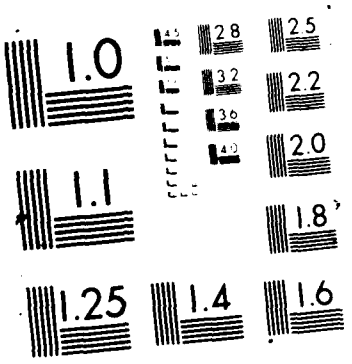
AD-A185 913 ASSESSMENT OF PHYSICAL ACTIVITY INTENSITY BY HEART RATE DURING SLEEP LIMI..(U) ARMY RESEARCH INST OF ENVIRONMENTAL MEDICINE NATICK MA R P MELLO ET AL. JUL 87 F/G 6/4 1/1 NL

UNCLASSIFIED




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

Assessment of Physical Activity Intensity by Heart Rate during Sleep Limited Military Operations

by

Robert P. Mello, James A. Vogel,
John F. Patton III and Bruce H. Jones

US Army Research Institute of Environmental Medicine
Natick, Massachusetts 01760-5007, USA

Address correspondence to: Robert P. Mello
Exercise Physiology Division
US Army Research Institute of
Environmental Medicine
Natick, MA 01760-5007, USA

SECURITY CLASSIFICATION OF THIS PAGE

AD-A182 912

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: U.S. Army Research Institute of Environmental Medicine; 6b. OFFICE SYMBOL (If applicable): SGRD-UE-PH	7a. NAME OF MONITORING ORGANIZATION: Same as 4. above.
6c. ADDRESS (City, State, and ZIP Code)	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 6.27.77.A; PROJECT NO. 3E162777A879; TASK NO.; WORK UNIT ACCESSION NO. 123

11. TITLE (Include Security Classification)
Assessment of Physical Activity Intensity by Heart Rate during Sleep Limited Military Operations.

12. PERSONAL AUTHOR(S) Robert P. Mello, James A. Vogel, John F. Patton III and Bruce H. Jones

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Manuscript	FROM July 1983 TO Aug 1983	July 1987	16

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	heart rate, prolonged work, physical fatigue, sleep deprivation.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This study estimated the intensity of physical activity of infantrymen by means of continuous heart rate (HR) recordings during a combat-simulated 5-day field operation. Subjects were 29 infantry soldiers comprising 4 rifle squads. Each squad rotated daily through 4 different combat-simulated field maneuver areas and repeated the first day's schedule on the fifth day. Soldiers slept approximately 5 hours per night and physical activity was monitored by taping HR with Oxford-Medilog cassette recorders. Daily HR (excluding sleep and resupply time) decreased from a mean of 101 beats per min (bpm) on day one to a mean of 89 bpm on day five. This suggests a progressive decrease in the intensity of physical activity as the 5-day operation progressed. A 10 km road march proved to be the single most demanding event resulting in a mean HR of 128 bpm for 140 minutes. Other periods of sustained high HR were associated with moving to and from mission objectives. Time at or above 50% of maximal HR averaged 38 minutes per day while time at or above HR 75% was 2.5 minutes daily, both times tending to decrease from day 1 to 5. The results of this study suggest 1) continuous cassette

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code); 22c. OFFICE SYMBOL

DD Form 1473, JUN 86 Previous editions are obsolete SECURITY CLASSIFICATION OF THIS PAGE

Assessment of Physical Activity Intensity by Heart Rate during Sleep Limited Military Operations

ABSTRACT

This study estimated the intensity of physical activity of infantrymen by means of continuous heart rate (HR) recordings during a combat-simulated 5-day field operation. Subjects were 29 infantry soldiers comprising 4 rifle squads. Each squad rotated daily through 4 different combat-simulated field maneuver areas and repeated the first day's schedule on the fifth day. Soldiers slept approximately 5 hours per night and physical activity was monitored by taping HR with Oxford-Medilog cassette recorders. Daily HR (excluding sleep and resupply time) decreased from a mean of 101 beats per min (bpm) on day one to a mean of 89 bpm on day five. This suggests a progressive decrease in the intensity of physical activity as the 5-day operation progressed. A 10 km road march proved to be the single most demanding event resulting in a mean HR of 128 bpm for 140 minutes. Other periods of sustained high HR were associated with moving to and from mission objectives. Time at or above 50% of maximal HR averaged 38 minutes per day while time at or above HR 75% was 2.5 minutes daily, both times tending to decrease from day 1 to day 5. The results of this study suggest 1) continuous cassette HR recording is a suitable method of monitoring the intensity of physical activity during strenuous field conditions 2) sustained high physical intensity is minimal in infantrymen during extended field operations, 3) this intensity of activity is adequately supported by an aerobic capacity of 50 ml O_2/kg.min, 4) the highest sustained HR is produced by marches or movements to contact, and 5) the physical fatigue and diminished sleep of combat operations may force infantrymen to perform at a slower rate regardless of operational demands as the exercise progresses.

Key Index Words: heart rate, prolonged work, physical fatigue, sleep deprivation.

INTRODUCTION

The rigorous demands of continuous field operations with minimal sleep tax both the physical and mental capacities of soldiers. The infantry soldier is required to perform a wide range of physical activities from short, quick bursts of energy to long, sustained marches over a variety of terrain. While energy costs have been determined for such combat activities as marching, running, climbing, crawling and load bearing (Consolazio, Johnson, and Pecora 1963; Goldman 1965; Consolazio 1971), little is known about the cumulative effects of performing all these activities with minimal sleep over the course of an extended 5-day period. In order to establish the fitness requirements necessary to perform under such conditions, it is essential to characterize the nature of the physical demands required for combat performance.

Because of the difficulties involved in the field estimation of energy expenditure by oxygen consumption ($\dot{V}O_2$) (Montoye and Taylor 1984), we chose to record continuous heart rate (HR) as indicative of energy cost (Acheson, Campbell, Edholm, Miller, and Stock 1980). While this report made no direct attempt to calculate energy expenditure from 24 hour HR measurement, data from 24 hour HR recordings were used to estimate the pattern and intensity of physical activity for the 29 military subjects throughout the course of the 5-day field operation.

METHODS

Subjects were 29 male volunteers from the 9th Infantry Division at Ft. Lewis, Washington. The soldiers were assigned to 4 separate squads of 7 to 8 men for purposes of completing a 5-day combat-simulated field exercise. During the week preceding the field exercise, aerobic power ($\dot{V}O_2max$) and maximal heart rate (HRmax) were determined using an interrupted treadmill running test patterened after Mitchell, Sproule, and Chapman(1958). Following the completion of these measurements, all subjects were given a day of rest prior to the 5-day field operation.

The combat-simulated field exercise was developed by the US Army Airborne Board at Ft. Bragg, North Carolina (Burkett and Lewis, 1983). The field

exercise required the squads to perform both offensive and defensive operations, using foot movement, on a nearly continuous basis. The 5-day exercise was conducted at the Infantry training area at Ft. Lewis, Washington. The majority of the area was heavily wooded with medium to thick underbrush. A swamp paralleled the eastern border of the test area, and all squads were required to cross this swamp at least twice during the field exercise. For purposes of this study, the training area was divided into 4 separate field maneuver areas, each with its own distinct mission schedule (Table 1). All squads began the field exercise with a 10 km road march to designated field maneuver areas. The four squads then rotated independently through each of the 4 maneuver areas for the first 4 days of the field exercise. On the last day, each squad repeated the maneuver area which it had performed on the first day of the exercise (Drews, 1984).

An aggressor force was present in the field maneuver areas for each day of the exercise. The squads executing the mission schedule of a specific maneuver area did not know the location of the aggressor force. The aggressor force performed its own mission schedule within each maneuver area, and could initiate contact of a "hit and run" intensity if the squad compromised its position in any way during the execution of mission activities. The agressor force was composed of 6 infantrymen armed with a variety of weapons (automatic weapons, simulated demolitions, training mines, smoke genades, artillery simulators, and an assortment of flares). The mission schedule for each maneuver area permitted repeated contact between the two forces on a daily basis throughout the exercise.

The subjects wore portable HR cassette recorders (Oxford-Medilog 4-24) which recorded HR during the entire 5-day operation. Three lead V5 ECG tracings were obtained with American Hospital Supply Plia-cell electrodes which were replaced as necessary each day. Cassette tapes were changed and the functional integrity of each subject's tape recorder and ECG electrodes were evaluated at 0600 daily. Cassette tapes were replayed, for computer analysis, through an Oxford-Medilog ECG analysis system, and the physiological demands of the field exercise were estimated on a minute by minute basis. A more detailed discussion of the HR analysis procedure can be found in Mello, Jones, Vogel and Patton (1986).

RESULTS

The overall fitness level of this group of subjects was good to excellent (mean $\dot{V}O_2max$ = 53.8 ml/kg.min) and comparable to other infantry groups (Daniels and Vogel 1984; Vogel, Patton, Mello, and Daniels 1986). The anthropometric and physiological data (mean $\pm$ SD) for the 29 subjects who participated in this study are listed in Table 2.

Table 3 summarizes the mean heart rates for all subjects over the course of the 5-Day field exercise. The average daily heart rate ranged from a high of 101 bpm on Day 1 to a low of 89 bpm on Day 5, Day 1 being the most physically demanding of the exercise. The major difference between the two days was the performance of a 10 kilometer road march by all squads at the beginning of Day 1, otherwise all mission assignments were identical. Table 3 is presented in the format of a 17 hour active period and a 5 hour sleep period. Analysis of the HR data tapes had revealed a 17 hour period of activity during the day and a 5 hour period of sleep for each evening. The hour immediately preceding and following the sleep period was used for recovery, resupply, and personal hygiene.

Figures 1-4 illustrate the mean hourly HRs for each squad on each day of the exercise. The major missions accomplished for each field maneuver area are written at the bottom of the graph together with the respective time of their execution. Only complete (24 hour) data tapes were used in plotting mean squad HR activity, hence individual squad N's may vary between the four figures.

Table 4 presents the total time at which 50% of maximal active HR or greater was attained. HR 50% is the net HR derived from subtracting each subject's resting HR from his treadmill maximal HR, multiplying by 0.5 and then re-adding the resting HR value. It is a useful indicator of the intensity of physical exertion (Karvonen, Kentala and Mustala 1957) and serves to reduce the amount of variation among subjects thus correcting for such variables as resting matabolic rate, characteristic individual HR, and state of training (Glagov, Rowley, Kraemer, and Page 1970). Day 1 was the most physically demanding of the field exercise for 3 of the 4 squads (HR 50% = 67 min). Also, the total time at or above HR 50% for all squads for the entire exercise was thirty-eight minutes. This means that on the average each

subject achieved 50% of net maximal HR for 38 min of each day during the course of the 5-Day operation.

Table 5 presents total time at the HR 75% level. The highest values were again observed on Days 1 and 2. The mean time spent on activity requiring greater than HR 75% for all subjects over the 5-day period was 2.5 minutes per day, a surprisingly brief period.

DISCUSSION

The main focus of this study was the use of recorded HR to estimate the degree of physical activity of 29 military subjects who completed a 5-day, sleep-limited, combat-simulated field exercise. For several reasons, no attempt was made to convert HR into kilocalories of energy expenditure. First, the derivation of a simple regression relationship from such specialized activities as running on a treadmill or riding a cycle ergometer might not hold true for the variety of activities performed by our subjects during the 5-day field exercise. Secondly, other complicating factors such as environmental temperature, previous exercise, emotion, food intake, fatigue, and smoking, could also influence HR without proportionally increasing energy expenditure (Montoye et al 1984).

Even though mission requirements were held constant, heart rate declined over the course of the five day period. This was reflected by the decrease in the mean 17 hour active HR (Table 3) as well as a declining trend in both HR 50% and HR 75%. When the mean HR value for day 1 was corrected for the 10 km march, HR was lower on day 5 than on Day 1, even though mission schedules were equivalent. It is possible that with the gradual onset of fatigue and sleep loss, soldiers paced themselves slower as the field exercise progressed to compensate for accumulated fatigue.

The physiological data from our study (Table 2) suggest that trained infantrymen should have had no difficulty in completing this 5-day, sleep-limited, combat field exercise. This was evidenced by the fact that the mean HR for all squads for the 17 hours of activity on each day of the exercise was 94 bpm (Table 3), approximately equivalent to 25% of the HR reserve (range between HRrest and HRmax). Furthermore, the mean HR's for all squads on all days were strikingly similar when compared over the entire duration of

the 5-day field exercise (94 bpm for the 17 hour active period, 59 bpm for the 5 hour sleep period).

The most demanding activity of the entire week was the 10K road march with a mean time of two hours and twenty minutes and an average HR of 128 bpm. Using the findings of the 10K march as a barometer (Figures 1-4), in almost all instances the highest sustained HR's were achieved when the squads were marching (either "moving to" or "moving away from" a military objective). The effect of the 10 kilometer road march can be appreciated by contrasting the 17 hour active HR's of Day 1 with those of Day 5 since maneuver area and mission assignments were identical for both days. Analysis of the HR tapes indicated that the 10k road march accomplished at the onset of Day 1 could not explain the 12 bpm difference between the two days.

Upon examining the data for all 4 squads in each of the field maneuver areas, an observation that becomes apparent is the consistency of the individual mean squad HR's over the course of an entire day, even though each squad accomplished the missions for each maneuver area on different days of the field exercise. In general, the most active part of the day was during the daylight hours and the periods of least activity were at night.

In conclusion, this 5-day, sleep-limited, field exercise produced relatively moderate physical demands that were well within the limits of the aerobic capacity typical of infantrymen. The results suggest continuous cassette HR recording is a suitable method of following physical intensity during strenuous field exercises. Although the field exercise was written to simulate actual combat the highest sustained HR was produced by marches or movements to contact, rather than actual engagement of the "enemy". Furthermore, the results suggest that the combination of limited sleep and physical fatigue may force infantrymen to accommodate by pacing themselves as the mission progressed. Although the physical intensity level was well within measured aerobic capacity levels, there were indications of fatigue, as evidenced by a gradually diminishing HR, when this moderate intensity was sustained over a 5 day period combined with moderate sleep loss.

References

Acheson, J.J., Campbell, I.T., Edholm, O.G. Miller, D.S. and Stock, M.J. (1980). The measurement of daily energy expenditure - an evaluation of some techniques. American Journal of Clinical Nutrition, 33,1155-1164.

Andrews, R.B. (1967). Estimation of values of energy expenditure rate from observed values of heart rate. Human Factors, 9(6), 581-586.

Bradfield, R.B. (1971). A technique for determination of usual daily energy expenditure in the field. American Journal of Clinical Nutrition, 24,1148-1154.

Burkett, G.S. and Lewis, J.D. (1983). Innovative test of physical fitness requirements for light infantry sustained combat operations, U.S. Army Airborne Board Project No. 2C026/TRADOC TRMS No. 3-000-395,

Consolazio, C.F., Johnson, R.E., and Pecora, L.J. (1963). Physiological measurements of metabolic functions in man (New York, Toronto, and London: McGraw-Hill).

Consolazio, C.F. (1971). Energy expenditure studies in military populations using Kofran-Michael's respirometers. The Americal Journal of Clinical Nutrition, 24, 1431-1437.

Daniels, W.L. and Vogel, J.A. (1984). Comparison of aerobic power and dynamic lift capacity with maximum performance during a 5-day sustained combat scenario. USARIEM Technical Report No. T4/85, Natick, MA: U. S. Army Research Institute of Environmental Medicine.

Drews, F.R. (1984). Physical fitness requirements for sustained combat operations of the light infantry - AWC Technical Report. Carlisle, PA: U. S. Army Physical Fitness Research Institute, Army War College.

Glagov, S., Rowley, D.A., Kramer, D.B. and Page, R.G. (1970). Heart rates during 24 hours of usual activity for 100 normal men. Journal of Applied Physiology, 29,799-805.

Goldman, R.F. (1965). Energy expenditure of soldiers performing combat type activities. Ergonomics, 8(3), 321-327.

Guidelines for graded exercise testing and exercise prescription (1980). American College of Sports Medicine, Philadelphia, PA: Lea & Febiger.

Karvonen, M., Kentala, K. and Mustala, O. (1957). The effects of training heartrate: A longitudinal study. American Medical Experimental Biology, 35, 307-315.

Mello, R.P., B.H. Jones, J.A. Vogel, and Patton J.F.III (1986). Assessment of physical activity intensity during infrantry combat-simulated operations. USARIEM Technical Report No T4/87, Natick, MA: U.S. Army Research Institute of Environmental Medicine .

Montoye, H.J. and Taylor, H.J. (1984). The measurement and estimation of energy expenditure: A review. Human Biology, 56,195-216.

Mitchell, J.H., Sproule, B.J. and Chapman, C.B. (1958). The physiological meaning of the maximal oxygen intake test. Journal of Clinical Investigation, 37, 538-547.

Vogel, J.A., Patton, J.F., Mello, R.P. and Daniels, W.L. (1986). An analysis of aerobic capacity in a large United States population. Journal of Applied Physiology, 60(2):494-500.

Table 1. Field maneuver area mission schedule

Field Maneuver Area	Time	Mission
	0600	Secure site & resupply
	1000	React to NBC
	1120	React to mortar fire
	1200	Establish rally point
1	1300	Conduct vehicular ambush
	2000	React to NBC
	2100	Establish rally point
	2200	Conduct raid
	2400	Establish patrol base
	0100	Stand - down
	0600	Secure site & resupply
	0800	Establish rally point
	0900	Establish personnel ambush
	1200	Conduct ambush/process POW
	1500-1900	React to sniper fire (2X)
2	1500-1900	React to Enemy Fire (2X)
	2000-2200	Defend Eastman Hill (2X)
	2230	Withdraw under pressure
	2245	Defend Folsom Hill
	2400	Critique & recovery
	0100	Stand - down
	0600	Secure site & resupply
	0700	React to ambush/NBC
	0800	Evacuate wounded
	1000	React to sniper/process POW
	1030	Secure site/conduct evacuation of wounded
3	1330	Conduct ambush
	1400	Area reconnaissance
	1900	Locate enemy outpost
	2030	Attach & seize outpost
	2200	Defend outpost
	2300	Establish base
	0100	Stand- down
	0600	Partisan linkup/resupply
	1300	Move to rally point
	1400	Conduct raid
	1500	Evacuate Wounded/partisan linkup
4	1600	React to enemy snipper fire
	2100	Enemy illumination/fire on landing strip
	2300	Defend landing strip
	2400	Critique & recovery
	0100	Stand - down

Table 2. Physical characteristics of subjects (Mean ± SD).

	Squad 1	2	3	4	Total
N	7	8	7	7	29
Age (Yrs)	23.1 ± 4	23.1 ± 3	21.4 ± 2	21.0 ± 2	22.2 ± 3
Ht(cm)	173.9 ± 7	174.6 ± 4	172.4 ± 8	173.7 ±10	173.9 ± 8
Wt(kg)	78.3 ± 9	73.1 ±11	72.9 ±13	76.3 ± 9	75.1 ±10
% BF	14.8 ± 5	14.0 ± 6	17.1 ± 5	17.0 ± 5	15.7 ± 5
$\dot{V}O_2max$ (ml/kg/min)	52.8 ± 5	54.6 ± 6	55.8 ± 6	51.9 ± 6	53.8 ± 6
HR_{max}	193 ± 7	192 ± 10	194 ± 8	194 ± 10	193 ± 9

Table 3. Mean heart rates during the 17-hour active and 5-hour sleep periods (mean ± SE; n = number of subjects).

		Day					
Squad		1	2	3	4	5	Total
1	Active	102±3	90±6	90±7	95±5	92±3	95±3
	Sleep	63±3	59±4	60±5	60±2	59±2	60±2
	n	5	3	2	6	6	5
2	Active	98±4	97±5	88±4	95±3	87±4	94±3
	Sleep	60±2	60±3	63±3	55±3	60±4	59±3
	n	8	8	6	6	5	5
3	Active	99±4	99±9	102±5	85±2	90±2	93±4
	Sleep	57±4	57±2	63±4	53±1	56±2	58±2
	n	5	3	3	5	4	5
4	Active	103±6	90±3	88±7	96±3	85±5	93±4
	Sleep	61±4	60±3	58±6	57±2	57±5	59±4
	n	6	7	4	6	5	5
Mean	Active	101±1	94±2	92±3	93±3	89±2	94±1
	Sleep	60±1	59±1	61±1	56±1	58±1	59±1

Table 4. Total minutes per day at or above heart rate 50%.

Squad	Mean HR 50%	Day 1	2	3	4	5	Avg
1	128 bpm	83	50	12	67	33	
2	133	81	72	24	35	36	
3	140	21	28	46	12	10	
4	138	83	14	21	23	17	
	135	67*	41	26	34	24	38.4 min

HR 50% = (HRmax - HRrest) X 0.5 + HRrest

*10 km Road March Performed on Day 1.

Table 5. Total minutes per day at or above heart rate 75%.

Squad	Mean HR 75%	Day 1	2	3	4	5	Avg
1	161	1.6	2.0	1.5	2.0	0.6	
2	162	6.4	3.0	0.7	2.0	3.6	
3	165	3.7	9.0	7.0	0.5	1.0	
4	167	2.0	0.0	3.0	0.0	0.4	
	164	3.4	3.5	3.1	1.1	1.4	2.5 min

HR 75% = (HRmax - HRrest) X 0.75 + HRrest

Figure Legends

Figure 1. Field Maneuver Area one. Heart rate/activity plot.

Figure 2. Field Maneuver Area two. Heart rate activity plot.

Figure 3. Field Maneuver Area three. Heart rate activity plot.

Figure 4. Field Maneuver Area four. Heart rate activity plot.

FIG 1

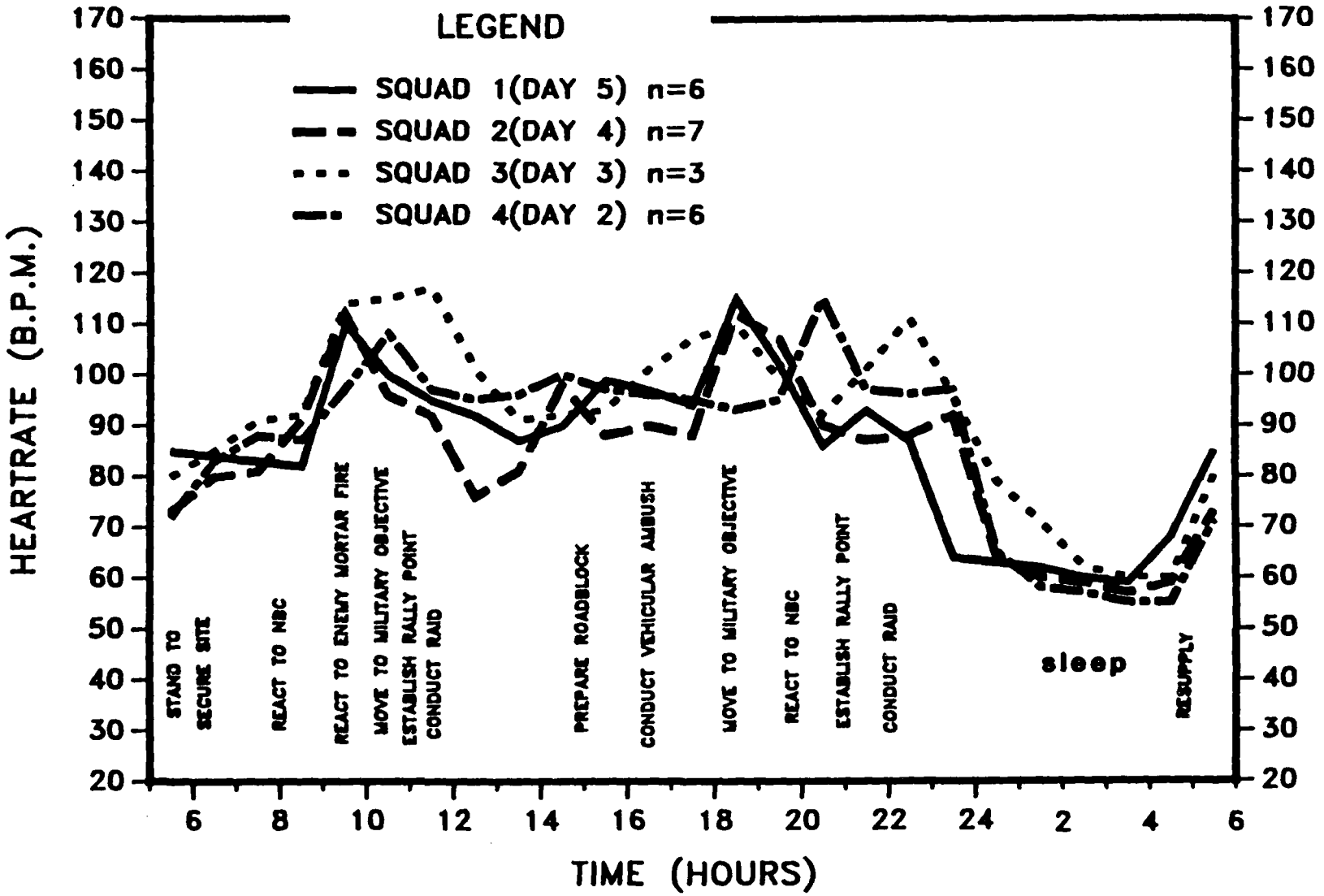

LEGEND
SQUAD 1(DAY 5) n=6
SQUAD 2(DAY 4) n=7
SQUAD 3(DAY 3) n=3
SQUAD 4(DAY 2) n=6
HEARTRATE (B.P.M.)
TIME (HOURS)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
6
8
10
12
14
16
18
20
22
24
2
4
6
STAND TO
SECURE SITE
REACT TO NBC
REACT TO ENEMY MORTAR FIRE
MOVE TO MILITARY OBJECTIVE
ESTABLISH RALLY POINT
CONDUCT RAID
PREPARE ROADBLOCK
CONDUCT VEHICULAR AMBUSH
MOVE TO MILITARY OBJECTIVE
REACT TO NBC
ESTABLISH RALLY POINT
CONDUCT RAID
sleep
RESUPPLY

FIG 2

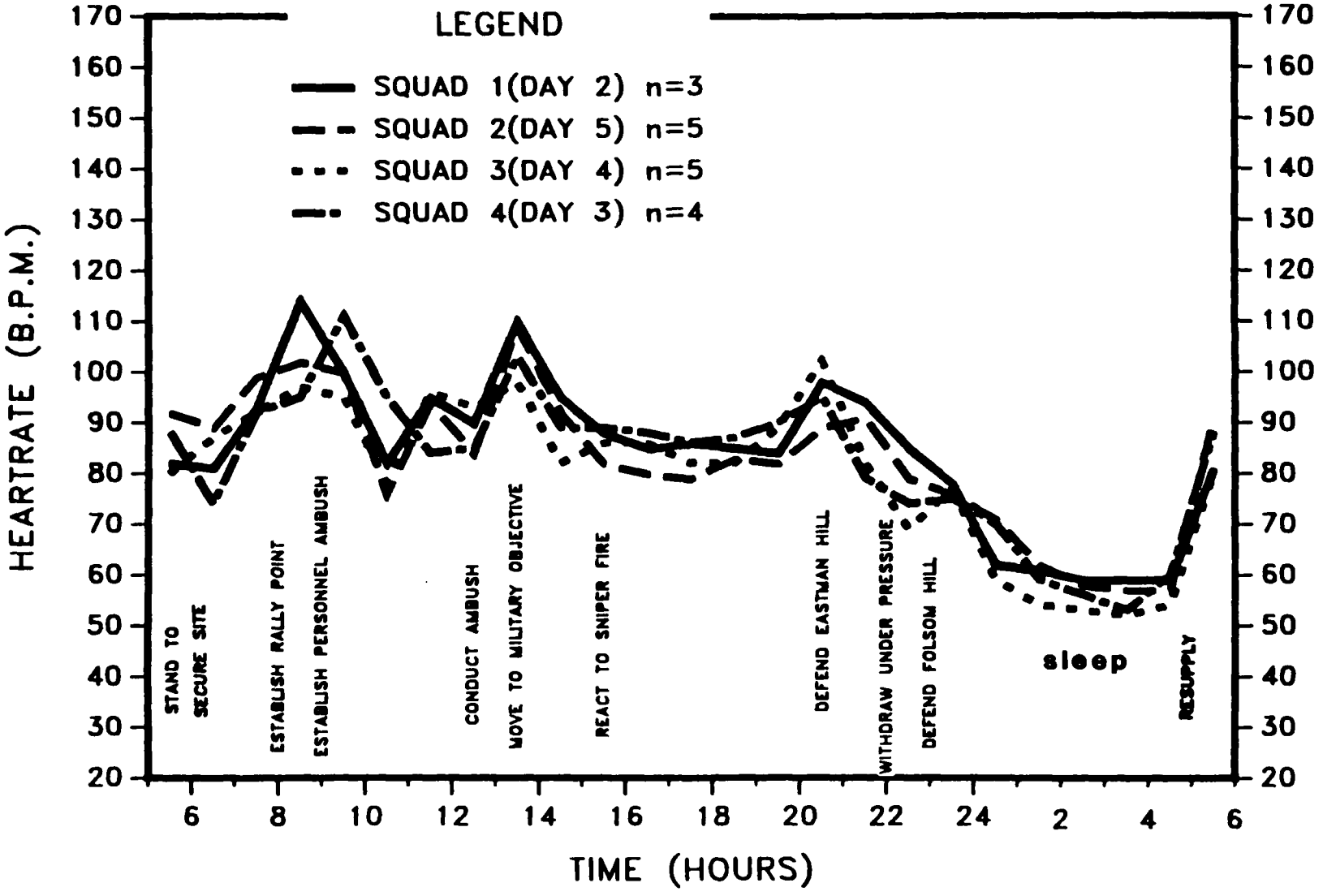

LEGEND
SQUAD 1(DAY 2) n=3
SQUAD 2(DAY 5) n=5
SQUAD 3(DAY 4) n=5
SQUAD 4(DAY 3) n=4
HEARTRATE (B.P.M.)
TIME (HOURS)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
6
8
10
12
14
16
18
20
22
24
2
4
6
STAND TO
SECURE SITE
ESTABLISH RALLY POINT
ESTABLISH PERSONNEL AMBUSH
CONDUCT AMBUSH
MOVE TO MILITARY OBJECTIVE
REACT TO SNIPER FIRE
DEFEND EASTMAN HILL
WITHDRAW UNDER PRESSURE
DEFEND FOLSOM HILL
sleep
RESUPPLY

FIG 3

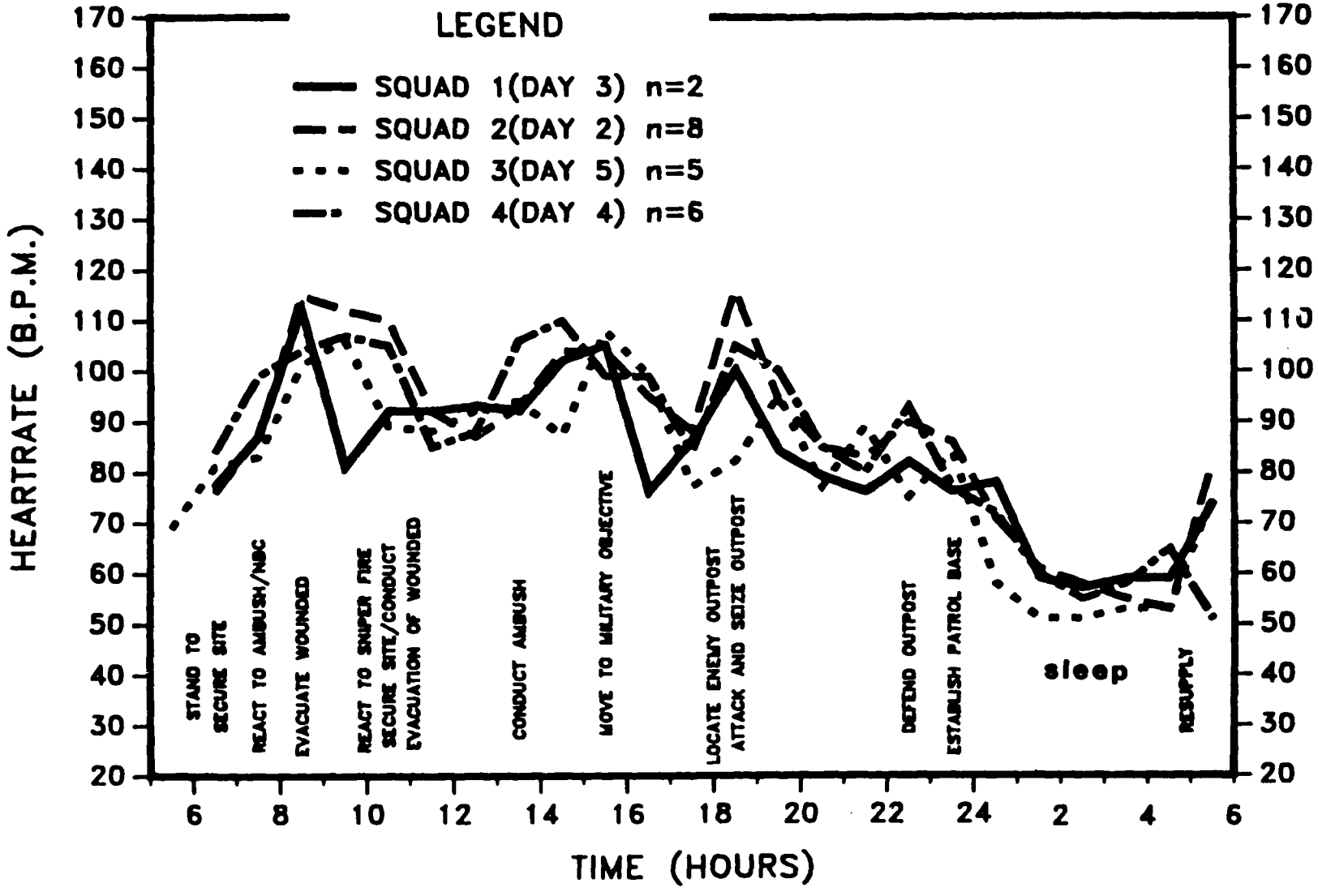
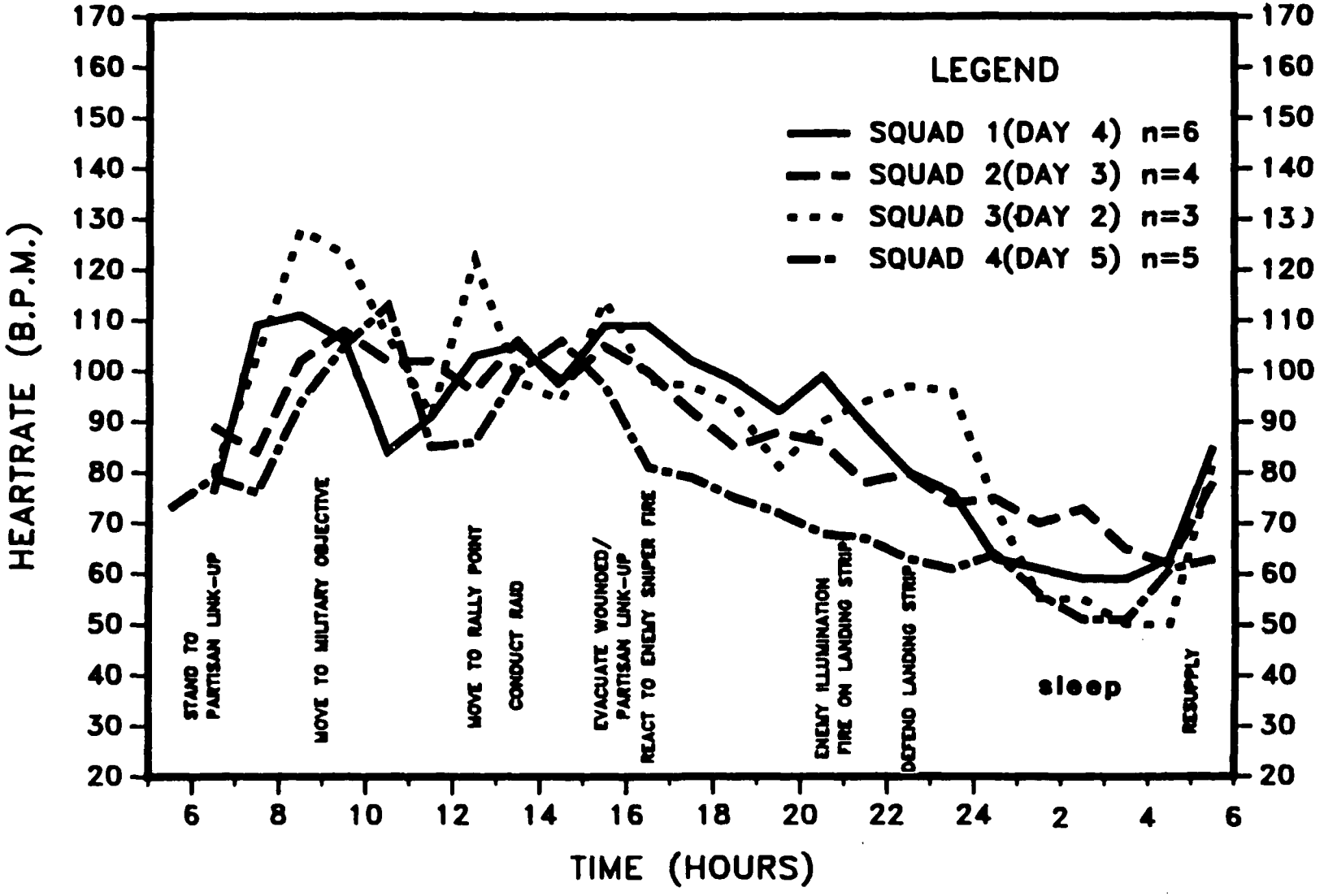

LEGEND
SQUAD 1(DAY 3) n=2
SQUAD 2(DAY 2) n=8
SQUAD 3(DAY 5) n=5
SQUAD 4(DAY 4) n=6
HEARTRATE (B.P.M.)
TIME (HOURS)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
6
8
10
12
14
16
18
20
22
24
2
4
6
STAND TO
SECURE SITE
REACT TO AMBUSH/NBC
EVACUATE WOUNDED
REACT TO SNIPER FIRE
SECURE SITE/CONDUCT
EVACUATION OF WOUNDED
CONDUCT AMBUSH
MOVE TO MILITARY OBJECTIVE
LOCATE ENEMY OUTPOST
ATTACK AND SEIZE OUTPOST
DEFEND OUTPOST
ESTABLISH PATROL BASE
sleep
RESUPPLY

FIG 4


LEGEND
SQUAD 1(DAY 4) n=6
SQUAD 2(DAY 3) n=4
SQUAD 3(DAY 2) n=3
SQUAD 4(DAY 5) n=5
HEARTRATE (B.P.M.)
TIME (HOURS)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
6
8
10
12
14
16
18
20
22
24
2
4
6
STAND TO
PARTISAN LINK-UP
MOVE TO MILITARY OBJECTIVE
MOVE TO RALLY POINT
CONDUCT RAID
EVACUATE WOUNDED/
PARTISAN LINK-UP
REACT TO ENEMY SNIPER FIRE
ENEMY ILLUMINATION
FIRE ON LANDING STRIP
DEFEND LANDING STRIP
sleep
RESUPPLY

END

12-87

DTIC